Index

Ablation properties of polymer nanocomposites, 425–520
EPDM nanocomposites studies, 435
NR and HNBR nanocomposites studies, 443
Phenolic nanocomposites studies, 465
Polymer-clay nanocomposites studies, 435
Thermoplastic nanocomposites studies, 431
Thermoplastic polyurethane nanocomposites studies, 444
Abstraction, wear, and scratch resistance characterization techniques, 566–568
Additive manufacturing, 401
AEROSIL, 77f2.54, 77f2.55, 76–78, 78f2.14, 82–83, 84f2.61, 106. See silicon dioxide
Aluminum oxide nanofibers, 65
Aluminum oxide nanofibers products, 68
Features and applications, 65
An overview of nanomaterials, 22–108
Aluminum oxide nanofibers, 65
Carbon nanofibers (CNFs), 42
Carbon nanotubes (CNTs), 48
Halloysite nanotubes (HNTs), 56
Layered double hydroxides (LDHs), 40
Montmorillonite (MMT) clays, 25
Nano-alumina (n-alumina), 82
Graphene platelets (NGPs), 32
Nano-magnesium hydroxide (n-Mg(OH)2), 90
Nano-silica (n-silica), 76
Nano-silicon carbides (n-SiC), 92
Nano-silver (n-Ag), 95
Nano-titanium dioxide (n-TiO2), 88
Nano-zinc oxide (n-ZnO), 97
Nickel nanostrands (NiNs), 62
One nano-scale dimension in the form of lamellar, 25
Polyhedral oligomeric silsesquioxane (POSS), 70
Three nano-scale dimensions in the form of particulates, 70
Two nano-scale dimensions in the form of fibers, 42
Applied Sciences, xviii, 42–43, 46, 48, 465, 468, 651, 656f15.5, 682, 685f15.39, 685f15.40, 686f15.41, 686f15.42, 690. See ASI and CNFs
Arkema, xviii, 55–56. See CNTs, Carbon nanotubes, and Multiwalled carbon nanotubes
Multiwalled carbon nanotubes, 104, 501, 504
Atomic force microscopy (AFM), 204. See AFM
BADGE, 176–177
bentonite, 25, 31t2.3, 31t2.3, 30–32, 149, 159, 583, 598
BET surface, 84f2.61
bismaleimide, 47, 112. See BMI
BMI, 47, 79, 113, 126
Brief history of nanotechnology, 4
Buckytubes, 49–50
carbon monoxide, 216, 393, 406t9.2, 621, 634f14.16
CNFs suppliers, 48
Manufacturing, 42
Origin, 42
Properties, 43
Carbon nanotubes, 48
Carbon nanotubes suppliers, 53
Classifications, 49
Double-wall carbon nanotubes, 53
Manufacturing, 48
Multi-wall carbon nanotubes, 51
Origin, 48
Properties, 48
Single-wall carbon nanotubes, 49
centrifugal mixing, 15, 169
Challenges for polymer nanocomposites, 684–689
Manufacturability of nanoparticles, 684
Manufacturability of polymer nanocomposites, 687
Char motor, 226, 486–487
Char strength sensor, 233–239
Compression sensor, 233
Shear sensor, 235
Characteristics of polymer nanocomposites, 130–131
chemical vapor deposition, 51. See CVD
CVD coefficient of thermal expansion, 45–46, 62, 130, 139, 177, 333, 342, 354, 354f8.25, 441. See CTE
Conductive Composites, 62, 63f2.38, 63f2.39, 63–65, 106
Compression sensor, 233
Conductive Composites, 62, 63f2.38, 63f2.39, 63–65, 106
Current regulation of nanomaterials and future perspectives, 637–644
Current trends in nanomaterials, 637
DuPont's nanomaterial risk assessment strategy, 639
Government perspectives on nanomaterials, 637
Regulation by industry, 640
Cytec Engineered Materials, 199, 224, 467–468, 474, 476, 486, 500, 503, 516, 519. See CEM
Definition of nanotechnology, 3–4
dental applications, 643, 658, 658f15.8
Differential scanning calorimetry, 209. See DSC
Dynamic mechanical thermal analysis, 210. See DMTA
Electrical properties of polymer nanocomposites, 521–549
Electrical properties of thermoplastic elastomer-based nanocomposites, 539
Electrical properties of thermoplastic-based nanocomposites, 521
Electrical properties of thermoset-based nanocomposites, 527
emulsion polymerization, 15, 174–175, 185, 529
Energy-dispersive x-ray spectroscopy, 192, 200, 263. See EDS and EDX
environmental and health, 14, 637, 645
Environmental health and safety aspect of nanomaterials, 606–610
Environmental effects, 608
Nanomaterial impact in biomedical and biological applications, 609
Safety of nanomaterials, 606
Environmental health and safety aspect of polymer nanocomposites, 610–614
Environmental effects, 613
Safety of polymer nanocomposites, 610
Environmental risk assessment of nanomaterials and nanocomposites, 614–621
Risk assessment for polymer nanocomposites, 618
Standards of testing nanomaterials, 617
Titanium dioxide risk assessment, 614
Epon, 139f4.5, 139–140, 140f4.6, 141f4.7, 141t4.3, 173, 373
Evonik, 77f2.54, 77f2.55, 79, 83f2.60, 84f2.62, 84f2.61, 89f2.70, 90f2.71, 304
Exolit, 397, 401, 623–624
fire resistance, 75, 116, 127, 233, 395, 403
Fire toxicity of polymer nanocomposites, 621–637
Fire toxicity characterization methods, 625
Fire toxicity properties, 627
Materials, 622
Flame retardant mechanisms of polymer nanocomposites, 411–417
flame retardant properties, 408, 411, 418, 501, 662
Flammability properties of polymer nanocomposites, 389–424
Multicomponent FR systems
One nano-scale dimension-based nanocomposites, 390
polymer nanocomposites combined with additional materials, 407
Three nano-scale dimensions-based nanocomposites, 401
Two nano-scale dimensions-based nanocomposites, 397
FTIR, 159, 174, 186, 349, 400, 406, 413, 464, 488, 569, 625, 627, 632–634, 644, 646
Halloysite nanotubes, 56
Fabricaton of polymer-HNT nanocomposites, 59
Features, 61
HNTs suppliers, 62
Origin, 56
Properties, 58
Heat capacity, 491–492, 502
High-shear mixing, 15, 27, 166, 176–179, 185
Ignitability, 213, 216
Insitu ablation recession and thermal sensors, 239–258
Ablation test results, 243
Design specifications, 251
Experimental setup, 252
Production of 0.55 mm TC sensor, 251
Production of the sensor plug, 241
Result and discussion, 254
Sensor calibration results, 242
The 0.25 mm diameter TC ablation sensor, 240
The 0.55 mm diameter TC ablation sensor, 249
Layered double hydroxides, 40
Origin, 40
Properties and applications, 41
Limiting oxygen index, 393, 402. See OI and LOI
Macrosurfaced nanosilica, 79
Applications, 82
Properties, 81
Mass loss calorimetry, 216. See MLC
Mechanical properties of polymer nanocomposites, 273–331
Thermoplastic elastomer-based nanocomposites, 289
Thermoplastic-based nanocomposites, 273
Thermoset-based nanocomposites, 307
Microscale combustion calorimetry, 217, 530, 534.
See MCC
MMT clays, 25
Cloisite product lines, 30
Nanocor product lines, 32
Organic surface treatment, 27
Organoclay suppliers, 28
Origin, 25
Structure, 26
Nano-alumina/Evonik, 82
Origin, 82
Properties, 83
Nano-alumina/Sasol, 85
Features, 86
Nanocomposite rocket ablative materials, 178, 224, 486. See NRAMs
Nanographene platelets, 32
Early and recent research on NGPs, 34
Nanographene platelet suppliers, 38
Origin, 32
Potential applications of NGPs and NGP nanocomposites, 37
Nano-magnesium hydroxide, 90
Global market and applications, 90
Nano-magnesium hydroxide suppliers, 92
Origin, 90

Nanomer, 30, 32, 142, 307–308, 308f7 .39
Nanoscale Science, Engineering, and Technology, 3–4, 690. See NSET
Nano-silica, 76
Applications, 77
Origin, 76
Properties, 76
Nano-silicon carbides, 92
Applications, 92
Nano-silicon carbides suppliers, 94
Origin, 92
Nano-silver, 95
Medical applications, 95
Nano-silver suppliers, 97
Origin, 95
Properties and applications, 95
Nanostructured materials, xvii, 71, 177, 185, 195, 221, 263, 437, 444, 471, 513, 516, 602, 664, 688
Nano-titanium dioxide, 88
Origin, 88
Properties, 89
Nano-zinc oxide, 97
Applications, 98
Nano-zinc oxide suppliers, 98
Origin, 97
National Nanotechnology Initiative, 4, 13, 637, 648, 650f15.1, 690. See NNI
National Science and Technology Council, 3–4, 690. See NSTC
Nickel nanostrands, 62
Features and applications, 64
Nickel nanostrands suppliers and products, 64
Origin, 62
Properties, 62
Nylon 11, 401–402. See polyamide 11
Nylon 12, 663. See polyamide 12

Oilfield applications of nanotechnology and nanomaterials, 590–599
Areas of application in the oilfield, 590
Drilling, 592
Enhanced oil recovery (EOR), 593
Examples of nanotechnology applications in oilfield, 593
Exploration, 592
Opportunities for polymer nanocomposites, 648–676
Commercial market opportunities, 651
Cost and property, and geographical breakdown analysis, 666
Nanomaterial consumer products inventory, 668
Technical and funding development, 667
U.S. government research funding opportunities, 648
Opportunities, trends, and challenges for polymer nanocomposites, 648–692
Index

Optical properties characterization, 259–262
Photoluminescence and electroluminescence spectroscopy, 261
UV-visible electronic absorption spectroscopy, 259
Optical properties of polymer nanocomposites, 550–565
Optical properties of thermoplastic elastomer-based nanocomposites, 557
Optical properties of thermoplastic-based nanocomposites, 550
Optical properties of thermostet-based nanocomposites, 560
Other properties of polymer nanocomposites, 566–602
Oxy acetylene test bed, 240, 504. See OTB
Oxygen index, 217. See Limiting oxygen index and LOI
Permeability properties characterization techniques, 581–582
Permeability properties of polymer nanocomposites, 581–590
One nano-scale dimension nanomaterial-based nanocomposites, 582
Three nano-scale dimensions nanomaterial-based nanocomposites, 587
Two nano-scale dimensions nanomaterial-based nanocomposites, 584
Polyamide 11, 397, 401, 421, 423. See PA11 and Nylon 11
Polyamide 12, 209, 523f11.1. See PA12 and Nylon 12
Polyhedral oligomeric silsesquioxane, 70
POSS
Features, 74
Origin, 70
POSS suppliers and products, 76
Properties, 71
PR-19-PS CNF, 447f 10.18, 484
PR-24-PS CNF, 166, 446t10.4, 446–447, 448f10.20, 472f10.47, 477f10.8, 477f10.8, 484–485
Processing of multifunctional polymer nanocomposites, 155
Processing of polymer nanocomposites, 155–190
Centrifugal processing, 168
Emulsion polymerization, 173
High-shear mixing, 176
In-situ polymerization, 170
Melt intercalation, 160
Roll milling, 166
Solution intercalation, 157
Synthesis methods, 155
Ultrasonic mixing, 179
PT-15, 178, 201, 201f6.9
Pyrograf, 42–43, 43f2.18, 43f2.19, 442f7.44–45, 45f2.20, 45f2.21, 48, 465, 651. See CNFs
Raman spectroscopy, 96, 206, 264
Scanning electron microscopy, 5, 38, 147, 192–193, 437f10.10.6, 438f10.7, 438f10.7, 443f10.12, 445f10.13, 445f10.14, 446f10.15. See SEM
Scanning impulse microscopy, 202. See SPM
Scanning tunneling microscopy, 203. See STM
Selective laser sintering, 391, 401, 408. See SLS
Silicon dioxide, 76–77, 79, 357, 497, 654, 671, 675
Simulated solid rocket motor, 15, 178, 468.
Small-angle X-ray scattering, 201. See SAXS
Southern Clay Products, xviii, 25, 27–28, 30, 99–100, 149, 164, 172, 277, 290, 293, 347, 431, 433, 468, 611, 653f15.2, 659f15.9, 691. See SCP
Steiner tunnel test (ASTM E 84), 220
Structures and properties characterization, 191–269
Ablation properties, 220
Electrical properties, 258
Electron microscopy and spectroscopy, 193
Flammability properties, 213
Global characterization methods, 191
Mecahnical properties, 207
Optical microscopy, 192
Optical properties, 259
Raman spectroscopy, 206
Scanning probe microscopy (SPM), 202
Small-angle X-ray scattering (SAXS), 201
Thermal conductivity, 211
Thermal properties, 209
X-ray diffraction, 193
X-ray photoelectron spectroscopy (XPS), 207
Subscale solid rocket motor, 166, 226, 447. See Char motor
SWNTs, 49, 207, 312, 355, 398, 528, 575
Tennis ball, 653f15.2
TGAP, 144f4.9, 145f4.5, 142–146
TGDMD, 144f4.10, 142–145, 145f4.5, 176–177, 359, 360f30, 388, 392–393, 393f9.2
Thermal conductivity, 211
Thermal properties of polymer nanocomposites, 332–388
Thermoplastic elastomer-based nanocomposites, 342
Thermoplastic-based nanocomposites, 332
Thermoset-based nanocomposites, 359
Thermogravimetric analysis, 209. See TGA
Index

Thermoplastic elastomer nanocomposites, 166, 230, 238f6.50, 239f6.51, 289, 294, 307, 513–514, 557. See TPUNs

Toyota Research Group, 185, 568, 665


See TEM

Trends for polymer nanocomposites, 676–684

Nanotechnology research output, 676

Trend and forecast, 677

Tribological properties of polymer nanocomposites, 566–581

Wear and abrasion resistance of polymer-clay nanocomposites, 568

Wear and scratch resistance of polymer-carbon nanotube nanocomposites, 574

Wear resistance of PTFE-Graphene nanocomposites, 578

twin screw extruder, 164, 296, 303, 535

Types of polymer nanocomposites, 131–151

Elastomer-based nanocomposites, 148

Thermoplastic-based nanocomposites, 131

Thermoset-based nanocomposites, 157

Types of polymers, 109–114

Elastomers, 114

Thermoplastics, 110

Thermosets, 111


ultrasonic mixing, 179. See ultrasonication

ultrasonication, 65, 67, 178, 181, 183, 184f5.25, 371, 375, 529, 531

Vacuum assisted resin transfer molding (VARTM), 79. See VARTM

vapor-grown carbon fibers (VGCNFs), 34. See CNFs

volcanic, 25, 25f2.2, 26f2.3

wide-angle x-ray diffraction (WAXD), 5, 263


X-ray photoelectron spectroscopy, 207. See XPS